EXHIBIT 15

ZONOLITE ATTIC INSULATION REPORT

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ZONOLITE ATTIC INSULATION

I. INTRODUCTION AND BACKGROUND

William M. Ewing, CIH of Compass Environmental, Inc., 1751 McCollum Parkway, Kennesaw, Georgia 30144, was requested to evaluate Zonolite Attic Insulation (ZAI) and to give opinions on its friability, fiber release potential, and its ability to contaminate buildings. He was also asked to opine on federal and state regulations governing asbestos, evaluation of ZAI in homes and appropriate response actions in buildings where ZAI has released asbestos fibers. Mr. Ewing is an expert on asbestos in building issues. He is qualified as an expert in this area as a result of his education, training and professional consultation in the field. In forming his opinion, he has performed certain work discussed below and reviewed government publications, scientific articles, and documents and testimony produced in this matter. He has also relied on his education, training and experience.

Mr. Ewing received a Bachelor of Science in Biology from Washington and Lee University. In 1978, Mr. Ewing began work at Clayton Environmental Consultants, Inc. in the field of industrial hygiene. In 1981, he joined the Georgia Tech Research Institute and started its industrial hygiene laboratory, instituted the hazardous waste program for small businesses in Georgia, was director of the EPA-sponsored Asbestos Information Center, and served as an industrial hygienist under the 7(c)(1) program, sponsored by the Occupational Safety and Health Administration (OSHA). In 1983, Mr. Ewing became board certified in the comprehensive practice of industrial hygiene. In 1987, he left the Georgia Tech Research Institute to take the position of Executive Vice President at the

Environmental Management Group, Inc. In 1990, Diagnostic Engineering, Inc. acquired Environmental Management Group, Inc. and employed Mr. Ewing as Regional Technical Director until 1993 when he joined the consulting firm, Compass Environmental, Inc., where he is currently the Technical Director.

During his career, Mr. Ewing has conducted numerous industrial hygiene, asbestos management and environmental studies. He has authored several publications and served on many committees, including governmental and industrial committees, to study the following: identifying asbestos in buildings, disposal of asbestos-containing materials, evaluation of asbestos-containing materials, and procedures for the abatement or containment of asbestos-containing materials in buildings. Mr. Ewing has also conducted asbestos surveys for asbestos management and control in commercial and government facilities, including commercial office buildings, schools, hospitals, ships, industrial plants and government buildings. In addition, Mr. Ewing has frequently directed or lectured in training courses sponsored by universities, government agencies and private interests on topics including respiratory protection, asbestos identification, evaluation, management and control and industrial hygiene. Mr. Ewing has provided asbestos-related consulting services to property managers and building owners throughout the nation.

Mr. Ewing has over 24 years experience evaluating asbestos in buildings in 42 states. He has conducted over 2,500 building inspections and designed asbestos abatement projects for over 100 buildings. He is accredited as an Asbestos Inspector, Asbestos Management

Planner, Asbestos Abatement Project Supervisor, and an Asbestos Abatement Project Designer pursuant to the Environmental Protection Agency (EPA) regulations.[1]

Mr. Ewing was formerly Director of the EPA-sponsored Asbestos Information Center at the Georgia Tech Research Institute. The primary mission of the center was to conduct training, research and provide technical assistance regarding asbestos in buildings. During the 1980s the Center trained over 10,000 people across the United States, Canada, and Europe on the methods of asbestos management. He served as Chairman of the Governor's Conference on asbestos in 1984 and 1985.

Mr. Ewing was invited to testify before OSHA regarding proposed changes to its asbestos regulations in 1984. He was invited by the EPA's Asbestos Action Program to serve as a technical advisor to the Regulatory Negotiation Committee for writing the Asbestos Hazard Emergency Response Act regulations in 1986-1987. He was invited to participate in the Congressionally mandated evaluation of asbestos in schools in the early 1990s.

Mr. Ewing has served on numerous advisory panels and peer review committees addressing asbestos-related topics. These panels and committees were sponsored by the EPA, the National Institute for Occupational Safety and Health (NIOSH), Navy (Shore Facilities Command), Army Corps of Engineers, General Services Administration, City of New York, Health Effects Institute, and the National Institute of Building Sciences.

[1] 40 CFR 763, Subpart E, Appendix C

Mr. Ewing served as an invited external peer reviewer for the EPA asbestos NESHAP revision.[2]

Mr. Ewing has published 19 articles on topics related to asbestos evaluation and control in buildings, and given over 50 presentations or papers on the subject at conferences or symposia. In recognition of his professional contributions he was designated a Fellow by the American Industrial Hygiene Association in 1995.

During the past 20 years Mr. Ewing has performed consulting, research and training relating to asbestos contaminated vermiculite in buildings. In 1987 he organized a technical session for the National Asbestos Council on the subject. More recently, in July 2002 he was invited to give a presentation at an ASTM conference on the subject of vermiculite mining in Libby, Montana.[3]

As a result of Mr. Ewing's work experience and asbestos training, he is qualified to offer opinions related to asbestos in building issues including the following: the nature and condition of ZAI in homes; air, dust and bulk sampling techniques; the contamination in a home resulting from ZAI; fiber release from ZAI under foreseeable uses of a home; the necessity to remove under strict industrial hygiene controls ZAI that may be impacted during a renovation or upon the demolition of the building. He is also qualified to offer opinions on guidelines and regulations issued by the EPA, OSHA and the Consumer

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[2] NESHAP – National Emission Standard for Hazardous Air Pollutants (40 CFR Part 61, Subpart M)

[3] Ewing, William M., "Libby…A Historical Perspective," presented at the ASTM conference *A Review of Asbestos Monitoring Methods and Results for the New York World Trade Center, Libby Vermiculite, and Fibrous Talc*, Johnson State College, Johnson, VT (July 21-25, 2002)

Product Safety Commission (CPSC) relating to asbestos. Mr. Ewing's qualifications and training are set forth more fully in his Curriculum Vitae. (Attachment 1). Mr. Ewing charges $165.00 per hour for his time plus reasonable and necessary expenses.

Mr. Ewing has testified as an expert on asbestos in building issues on several occasions in both federal and state court. Included in Attachment 1 is a list of Mr. Ewing's asbestos expert deposition and trial testimony over the last five years.

II. NATURE OF ZONOLITE ATTIC INSULATION

The term Zonolite Attic Insulation (ZAI) refers to expanded vermiculite from the W.R. Grace (formerly Zonolite) Libby, Montana vermiculite mine. Vermiculite is a weathered form of mica that expands to at least 10 times its volume when heated. The term vermiculite has its Latin roots in the term *vermiculari* meaning to breed worms. This vermiculite, which is contaminated with fibrous tremolite and related forms of asbestos (winchite asbestos, richterite asbestos and fibrous actinolite), was shipped from the mine to an on-site mill where the vermiculite was separated from the other rock in the deposit. The vermiculite was then shipped to expanding plants around the country where it was poured into furnaces which utilized its internal moisture to "pop" it, much like popcorn.[4] Unlike most asbestos-containing products (spray fireproofing, acoustical plaster, floor tile, etc.), the asbestos-contaminated vermiculite used for ZAI was not mixed with any binding material (gypsum, cement, etc.) but was poured directly into bags for sale to consumers. Thus, unlike Grace's spray fireproofing product ("Monokote"), for instance,

which had a gypsum binder that Grace contended "locked in" the asbestos fibers, ZAI had no such binder, at least until the late 1970s. Although ZAI had been sold since at least the 1920s[5], according to Grace records, it was not until the late 1970s that Grace attempted to spray any kind of binder on the vermiculite being poured into the bags. Grace documents reveal that this belated binding effort was sporadic and often ineffective. The majority of ZAI in homes today is likely to be unbound.

The nature of the ZAI preparation process, which subjected the vermiculite to hammermilling at the mill and thermal expansion in the furnaces, resulted in some of the amphibole asbestos being liberated as individual fibers. Grace's internal documents report its microscopic analysis that tremolite could be seen lying on the surface of the vermiculite. As would be expected from such unbound asbestos, any disturbance of the material in handling would liberate additional asbestos fibers lying on the vermiculite pieces. Grace documents reflect that ZAI was known to release asbestos from handling. Other disturbance, such as blowing air over the vermiculite, was also found to liberate asbestos fibers. In the rebuttal to the U.S. Patent Office's denial of the initial patent application for a Zonolite-based product, it is stated, "Applicants' mass is friable, loose and flaky, and so lacking in physical strength as to be broken up at the touch. It has about the same strength as the ashes left on the end of a cigar."[6] From the review of Grace

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[4] The expanded vermiculite has a golden color when expanded in an oxidizing environment, and a silver color when expanded in a reducing environment. Zonolite was reported available in both colors; See the Zonolite Company, Libby, MT, *Zonolite "Montana's Mineral Marvel,"* (circa 1928).

[5] The Zonolite Company, Libby, MT, *Zonolite, As A Heat Loss Insulator in Buildings: Warmer in Winter – Cooler in Summer* (sales pamphlet), (Circa 1928).

[6] From the U.S. Patent Office file for Patent No. 1,693,015 awarded to Joseph A. Babor and William L. Estabrooke, November 27, 1928. Quotation from Brief for Babor and Estabrooke before the hon. Commissioner of Patents, New York, September 20, 1928.

documents, as well as my own work discussed herein, I conclude that ZAI is a highly friable asbestos product.

III. ASBESTOS WEIGHT VERSUS ASBESTOS FIBER COUNT

I understand that Grace contends that because ZAI often had less than 1% asbestos by weight, it should not pose a building contamination or potential health concern. The data I have reviewed indicates that ZAI in some homes has tested at more than 1% asbestos.[7] This would not be surprising since the asbestos content of the Libby vermiculite deposit varied significantly.[8] It would be expected that vermiculite ore with varying asbestos percentages entering the Libby mill would result in an expanded vermiculite that also had varying asbestos percentages leaving the expanding plant.

However, more important, than whether ZAI had more or less than 1% is the fact that the asbestos in ZAI, at least through approximately 1980 (four years before ZAI was discontinued), was totally unbound, highly friable and subject to release from normal handling. Grace officials conceded that even "bound" ZAI released asbestos fiber upon disturbance. In any event, it is not asbestos weight, but fiber release that is important. An asbestos product with a significant percentage of asbestos may pose little or no hazard in normal use, such as a solid asbestos-containing laboratory table. However, a product with a small percentage of asbestos by weight or volume can pose a significant hazard if the fibers are unbound and can be released from the product to become airborne. Once airborne, the fibers pose an immediate exposure hazard to persons in the area. These

[7] Shelborne Laboratories, Progressive Builder Vermiculite Sample #2, April 21, 1987 reported as 5% tremolite asbestos; See Fisette, Paul, *Progressive Builder*, pp. 35-36 (July 1987).

fibers eventually settle onto building surfaces where they may be suspended into the air again, thereby creating a repeated exposure potential. The ZAI studies described in this report confirm that disturbance of ZAI, as would be undertaken during foreseeable homeowner activities, can release significant amounts of Libby amphiboles (i.e., fibrous tremolite, actinolite, and related amphiboles). After being released in the air, the asbestos will settle on surfaces in the home, primarily the attic and any area to which Libby vermiculite has migrated. As shown by our home inspections, Libby vermiculite has an affinity for seeping through cracks and crevices and entering living space.

The importance of the propensity for asbestos to be released, rather than its weight in a product, was known to W.R. Grace. Internal Grace documents reflect concern that asbestos fiber release from ZAI (not weight) was the critical issue, and that ZAI being sold in the 1970s could not meet the then-current occupational standards, which were more lenient than today. ZAI would certainly not meet the current, more stringent OSHA standards, based on the Grace test results.

Likewise, it is helpful to focus on the fiber level readings from the studies conducted and attached to this report (Attachments 2 and 3). The tests in the Busch residence, for example, indicated that when ZAI was disturbed by moving it aside using the Grace method, as would be done to install a pull-down stairway in an attic, the activity generated 6.29 structures per cc. There are 1000 cubic centimeters in a liter. Thus, 6.29 structures per cc equals 6,290 structures per liter. An adult breathes approximately 10

[8] Note: Zonolite mountain was formerly exploited by the Vermiculite and Asbestos Co. for both vermiculite and asbestos before its merger with The Zonolite Company in 1939.

liters of air per minute. Thus an adult exposed in an attic to 6.29 structures per cc of asbestos, as generated in the simulation, would inhale about 1,887,000 fibers of asbestos during 30 minutes in the attic.

IV. AIR TESTING VERSUS DUST TESTING

In order to determine whether asbestos could be released into the air from ZAI during foreseeable disturbance, a series of studies were conducted. It is important to realize, however, that while the studies demonstrate the ability of ZAI asbestos dust to become airborne, airborne asbestos readings are not recommended by EPA to be the primary tool to assess asbestos contamination in a building. Airborne fiber levels are transient, depend on the activity in the area, vary with sampling locations and present only "snapshots" of the air during the time the samples are collected. This issue has been addressed by EPA on a number of occasions. In an EPA publication of June, 1985 *Guidance for Controlling Asbestos-Containing Materials in Buildings*, the agency stated, "It (air testing) measures only current conditions and provides no information about fiber release potential and future air levels."[9] EPA again addressed the issue in its 1987 Asbestos Hazard Emergency Response Action Regulations:

> Several commentors, primarily from industry, encouraged the establishment of air monitoring standards as the primary basis for hazard assessment.
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> ...
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> EPA continues to discourage the use of air monitoring as the primary technique for assessing asbestos hazards, since that method only measures current conditions and provides no information about potential and future levels of fiber release.
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> ...

[9] USEPA, *Guidance for Controlling Asbestos-Containing Materials in Buildings*, Publication N. EPA 560/5-85-024, P. 4-3, (June 1985)

> Several industry commentors proposed that EPA adopt air monitoring standards for damaged and significantly damaged ACM [asbestos-containing material].
>
> ...
>
> The agency believes that such standards used for purposes of assessing asbestos hazards could not ensure protection of human health and the environment as intended by TSCA Title II.[10]

EPA has also recognized that reliance solely on air monitoring can miss episodic events in a building, as would occur in the studies when ZAI was disturbed in an attic. EPA has noted that air monitoring may underestimate exposures because, "Air monitoring may not be done frequently enough to include such episodic events [repair work or accidental disturbance]; this can lead to a misleading interpretation of air sampling results."[11] Grace air tests, which show little or no asbestos in a ZAI-insulated attic when no activity is occurring, are examples of missing episodic events, as shown by our studies of foreseeable activities in attics which generated elevated asbestos levels.

Rather than relying primarily on air testing, EPA has recognized that trained and accredited asbestos inspectors are qualified to determine from visual inspections of debris if friable asbestos-containing materials pose a building contamination problem. In the case of ZAI, this is not a difficult determination because ZAI by its nature resembles the asbestos-containing debris that building inspectors often look for in buildings with other types of asbestos-containing materials. In the case of ZAI, surface dust analysis is particularly useful to determine if a building area is contaminated. Since the Libby amphiboles do not appear naturally in the rest of the country, except in Libby, MT and

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[10] Federal Register, Vol. 52, No. 210, p. 41838 (October 30, 1987)

perhaps in the vicinity of some expansion plants, there is no "background level" of Libby amphibole asbestos in settled dust. However, chrysotile asbestos, the type used in many industrial products, has been found in background urban air and many settled dust samples. Thus, a finding of any Libby amphiboles in settled dust in homes with ZAI indicates that the Libby amphiboles have escaped from the ZAI and contaminated the building surfaces. Air testing simply confirms that those fibers can become airborne to be breathed by building occupants, including contractors who may work in the homes rewiring electricity, fixing plumbing leaks, installing attic fans, stringing cable TV lines, installing telephone wiring, etc.

In contrast to air testing, surface dust testing indicates whether the *building* itself is contaminated, versus the *air* contamination data given by air testing. Dust testing has been conducted for asbestos since at least 1935 when a Harvard professor examined settled dust from rafters and published photomicrographs of the results.[12] In 1972, Dr. Selikoff conducted settled dust testing in homes where asbestos workers had lived previously.[13] EPA has expressed its concern about the "resuspension of previously released fibers that have settled onto floors and other surfaces".[14] The agency has noted that:

> Resuspension of asbestos fibers that have settled may result from many different activities, including dusting, sweeping, vacuuming, and even ordinary movement in the vicinity of the settled fibers. This process of release and resuspension of asbestos fibers results in continued dispersal of asbestos fibers throughout the building.[14]

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[11] USEPA, *Managing Asbestos in Place, A Building Owner's Guide to Operations and Maintenance Programs for Asbestos-Containing Materials*, Publication No. 20T-2003, p. 15, (July 1990)
[12] Hurlbut, C., "The Mineralogy of Asbestos Dust", Journal of Industrial Hygiene 17:289-293 (1935)
[13] Selikoff, I.J. et al, "Asbestos Air Pollution", Archives of Environmental Health 25:1-13 (1972)
[14] Federal Register, Vol. 47, no. 103, p. 23361. (May 27, 1982).

More recently EPA has noted that "[d]ry sweeping or dusting can result in asbestos fibers being re-suspended into the building's air and therefore should not be used".[15] Quite recently, EPA has used dust sampling as part of its analysis efforts for asbestos contamination in the homes in Libby, Montana. As EPA informed the public in its EPA Fact Sheet:

> "Asbestos fibers in dust are measured using (TEM) after an indirect preparation step. The indirect preparation involves dissolving the filter and removing everything but asbestos fibers."[16]

The effectiveness and reproducibility of the microvac technique for settled dust, as utilized in the ZAI evaluations discussed herein, has been confirmed by independent analysis.[17]

Asbestos in settled dust has been not only a concern to the industrial hygiene community generally, but also to W.R. Grace. In October 1988, W.R. Grace commissioned an asbestos survey of one of its plants which included testing for "residual surface contamination". The consultant reported "visual surface contamination present in several areas of the battery separator warehouse and boiler room". The consultant recommended that workers not conduct any dry sweeping or vacuuming and that the contamination be cleaned up.[18] The Montana Board of Health had reported its concern to W.R. Grace after an inspection at Libby that "the rafters were heavily loaded with dust. Much of the high dust concentrations noted were due to this dust falling off the rafters and other places of

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[15] EPA, *Managing Asbestos in Place*, p. 19. (1990).
[16] EPA Fact Sheet: Asbestos Sampling in Libby, MT (May 2000).
[17] Crankshaw, O., "Quantitative Evaluation of the Relative Effectiveness of Various Methods for the Analysis of Asbestos in Settled Dust", Research Triangle Institute.
[18] Asbestos Survey W.R. Grace – Acton facility (October 1988).

deposit."[19] The Montana State Board of Health industrial hygiene report of 1956 conducted at the Libby plant relied on the dust sampling data performed by Zonolite Corporation at an earlier date. Zonolite Corporation had found 8 to 21% asbestos in the dust.[20] In June, 1969, W.R. Grace's Safety Director reported that his visit to a Grace facility revealed "dust accumulations ... all horizontal surfaces was extremely heavy ... Building vibration dislodged ledge accumulations creating a vicious cycle."[21]

In 1983, while Grace was still selling ZAI, Grace personnel recognized the dangers of asbestos in vermiculite dust:

> I feel the employees do not comprehend the relationship between a pile of spilled vermiculite and a health hazard. Fibers are basically an invisible villain. WE must reeducate ourselves and our employees to treat vermiculite as a "hazardous" product.[22] (emphasis in original)

W.R. Grace has recognized that building contamination, as evidenced by surface dust, requires remediation without consideration of air sampling. When Grace was planning to renovate part of its Cambridge, Massachusetts' facility, it discovered asbestos-contaminated talc dust on floors, beams, pipes and other horizontal surfaces. Grace concluded that talc waste was not covered by the NESHAPs regulations, "as the waste does not contain commercial asbestos".[23] Nevertheless, Grace's specifications for the clean-up of this talc, (which contained no more than 2% asbestos), required isolation of the work area, protective clothing and special cleaning methods.[24] In 1984, a Grace industrial hygienist noted a "problem with asbestos dust contamination on the surfaces of

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[19] May 11, 1964 Letter from Benjamin F. Wake to R.A. Bleich.
[20] Wake, Benjamin F., Montana State Board of Health, A Report on an Industrial Hygiene Study of the Zonolite Company of Libby, MT, August 8-9, 1956, p.3
[21] June 20, 1969 Memo Peter Kostic to G.C. Cunningham.
[22] June 15, 1983 Memo from Winkel to Wright.

materials stored in (a Grace building)". Grace ordered an "intensive clean-up" by the contractors who had been working in the building disturbing asbestos.[25] Grace noted in 1985 that asbestos-contaminated dust could settle on people, as well as surfaces:

> Clothing picks up and traps tremolite fibers and, if not periodically cleaned, continuously releases them into the workmen's breathing zone at an increasing rate.[26]

A Canadian researcher hired by Grace to study its Libby operation took 21 dust samples at a Grace facility and reported the number of fibers per milligram of dust.[27]

The dust sampling method used for settled dust sampling and analysis in the ZAI home evaluations was ASTM method 5755.[28] This method reports asbestos structures per unit of area sampled.

V. ZAI STUDIES AND GRACE'S ZAI TESTING

As part of our investigation of Zonolite insulation, we undertook a series of tests to evaluate exposures from reasonably foreseeable activities in homes containing Zonolite insulation. These activities included the following:

- Cleaning of stored items in an attic with Zonolite at perimeter only
- Cleaning of an attic completely insulated with Zonolite
- Cutting a hole in a ceiling of a living space below Zonolite attic insulation (ZAI)
- Moving aside Zonolite attic insulation using the Grace method
- Moving aside Zonolite attic insulation using a homeowner method
- Removal of Zonolite insulation from the top of wall cavities with a shop vacuum

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[23] March 21, 1984, Building Interior, Cleaning Specification.
[24] Building Interior, Cleaning Specification (1984).
[25] T.E. Hamilton August 23, 1984 Memo to D.C. Wightman.
[26] March 26, 1985 Memo from McCaig to Stowell.
[27] McDonald, J.C., et al, "Health of Vermiculite Miners Exposed to Trace Amounts of Fibrous Tremolite", British Journal of Industrial Medicine, 1988, 45:630-634.

These activities were undertaken to simulate the types of normal activities and renovations that would be expected in homes.

In addition to conducting these tests, W.R. Grace testing of ZAI was reviewed. From the test reports provided, there was no evidence that Grace had tested ZAI under many of the foreseeable conditions of disturbance that could occur in a home after ZAI was installed. The Grace ZAI tests are primarily simulation studies (including "drop" tests), or actual installation tests. Some post-installation air samples taken in attics with no apparent activity were also reviewed. Although Grace (Zonolite) has been selling attic insulation since the 1920s, the earliest ZAI testing provided to us began in the mid-1970s. These earliest tests, conducted on what Grace described as its "production material," showed extremely high fiber counts, some in excess of even the higher OSHA permissible exposure limits of that time. Since these tests were run on the production material, it can be reasonably be concluded that inexperienced homeowners installing ZAI would have been exposed to at least these levels, if not higher. Some of the tests were performed in a "drop test" room or "simulated attic." According to the deposition testimony of Ms. Julie Yang, Grace did not always follow the standard microscopic counting rules described by the NIOSH. Rather, Grace undercounted the fibers by eliminating those that Grace microscopists judged were not tremolite.[29] All fibers should have been counted and, if in the opinion of the microscopist, there was additional information to disregard some fibers this should have been clearly stated and a second count provided with an explanation. As someone who did work on the concept of discriminatory counting from 1979-1983, I feel

[28] ASTM method 5755, *Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Concentrations* (2003)

certain that using only a light microscope it would have been very difficult to validly eliminate such fibers as cellulose, and many thin fibers. Accordingly, it must be assumed that many of the analyses performed by the Grace laboratory in Cambridge undercounted the true fiber content of the sample.

The OSHA standards were not intended in the mid-1970s to be "safe" levels of asbestos exposure. OSHA continues to reiterate this fact regarding today's standard as well. Both OSHA and NIOSH has explained on numerous occasions that there is still a significant risk for asbestos-related disease at the "permissible exposure level" (PEL) it has set. The PEL is a regulatory trade off, which takes into account technical and economic feasibility considerations. The OSHA standards do not apply to homeowners or children.

Review of the Grace installation testing also reflects that Grace often reduced the fiber levels measured by 75% because Grace contended that a homeowner would install an entire attic of ZAI in two hours (out of an eight-hour day) and would have no further exposure to ZAI thereafter. The testimony of homeowners in this proceeding refutes this. Homeowners often took several days to install ZAI and had additional exposure through work in the attic thereafter. Grace's claim that homeowners would conclude an attic job in two hours is contrary to Grace advertising that the job would take four hours or more. Grace also often sampled only during the actual pouring, thus missing any continuing exposure during clean up. Fiber levels are likely to stay elevated for some time after ZAI disturbance. With respect to the issue of hazard posed by ZAI, the Grace installation testing in the late 1970s reflects fiber counts that exceed the OSHA 1976 ceiling

[29] Deposition of Julie Chi-Sun Yang taken February 20, 2003, p.98

concentrations, which is a level that is not to be exceeded at any time. These excess levels were recorded, apparently using Grace's "discriminatory counting" (which lowered the numbers recorded).

It was foreseeable that ZAI installed in a home could cause additional fiber exposure upon disturbance. There was nothing in the nature of ZAI that would cause the fibers in ZAI to bind or disappear after installation. Unlike other asbestos-containing products, ZAI did not set, harden, cure, or in any way chemically react to confine the asbestos fibers within the product. Rather, the fibers that were loose when ZAI was installed remained available to be reentrained upon disturbance of the ZAI. Renovation of structures is clearly foreseeable over their lifetime.

As noted above, to determine levels of ZAI fiber release during foreseeable home activities, we undertook a series of simulations that are detailed in Attachments 2 and 3. These studies clearly demonstrate that significant exposures occur when ZAI is directly disturbed. They also demonstrate that exposures can occur through routine cleaning activities in attics where Zonolite dust is present. Our studies did not look at activities such as major home renovations or demolition activities that would be expected to result in higher airborne levels of asbestos.

One study, conducted by the Canadian Department of National Defense in 1997 did look at exposures to asbestos from contaminated vermiculite attic insulation in base buildings

during demolition practices.[30] In this study workers demolished a ceiling, let the attic insulation drop to the floor, shoveled the waste into the back of a truck, and unloaded the waste at a landfill. The TEM results (NIOSH method 7402) found 4.4-174 f/ml (greater than 5 micrometers) during ceiling demolition and clean up for the personnel doing the work, and 64.5-152 f/ml (greater than 5 micrometers) for the workers unloading the waste at the landfill. Bulk samples of the tremolite-actinolite contaminated vermiculite indicated it contained only a "trace" of the amphibole contamination (less than 0.1%). These data further support and clearly confirm that seemingly very small amounts of asbestos as a contaminant in a product such as ZAI can result in very excessive exposures.

[30] Pinchon Environmental, Site Assessment, Vermiculite Removal, Building E-12, C.F.B. Shilo, Shilo, Manitoba, Department of National Defense, Base Construction Engineering, April 3, 1997

ATTACHMENT 1

WILLIAM M. EWING, CIH
Compass Environmental, Inc.
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Kennesaw, Georgia 30144

Education

B.S., Biology, Washington and Lee University	1978
Courses in Management, Statistics, Technology and Science Policy (University of Michigan, Georgia State, Georgia Tech)	1978-1988
Short courses in industrial hygiene, toxicology, indoor air quality environmental site assessments, asbestos evaluation and control	1978-Present

Employment History

Compass Environmental, Inc. Technical Director	1993-Present
Diagnostic Engineering Inc. Regional Technical Director	1990-1993
The Environmental Management Group, Inc. Executive Vice President	1987-1990
Georgia Tech Research Institute Research Associate II	1981-1987
Clayton Environmental Consultants, Inc. Industrial Hygienist	1978-1981

Experience Summary

Mr. Ewing is currently the Technical Director for Compass Environmental, Inc. In this capacity he serves as project manager for industrial hygiene, indoor air quality, and environmental site assessments. His technical responsibilities include project design, execution and report development for private and government project sponsors. He is also responsible for research studies, preparation of papers and publications, and quality assurance. He was the Executive Vice President of The Environmental Management Group, Inc. (TEMG) prior to its acquisition by Diagnostic Engineering Inc. (DEI), where he served as Regional Technical Director. While at the Georgia Tech Research Institute (GTRI) he started the industrial hygiene laboratory, instituted the hazardous waste program for small business in Georgia, and served as an industrial hygienist under the 7(c)(1) program, sponsored by the Occupational Safety and Health Administration (OSHA). As Director of the Asbestos Programs Group, he conducted training, technical assistance, and research on asbestos in buildings, under the sponsorship of the U.S. Environmental Protection Agency (USEPA).

During the past 20 years Mr. Ewing has conducted numerous industrial hygiene, asbestos management, and indoor air quality studies. In the field of industrial hygiene he has conducted over 200 field investigations including textile mills, foundries, steel mills, health care facilities, chemical plants, and manufacturing operations. Among the indoor air quality projects, his experience includes office settings, hospitals, and studies involving off-gassing of volatile compounds from products. He has served as a consultant to the Centers for Disease Control (CDC) on airborne microbial contamination, and is currently a consultant to the U.S. Public Health Service. He is currently a consultant to the Georgia Building Authority where he conducts IAQ investigations and authored the State of Georgia IAQ manual. Since 1980, he has conducted environmental assessments for property owners, developers, mortgage bankers, and insurance companies. In the field of asbestos management and control, he has conducted surveys of over 1200 facilities, including commercial office buildings, schools, hospitals, ships, industrial plants, and government facilities.

During the past 15 years, Mr. Ewing has frequently directed or lectured in training courses sponsored by universities, government agencies, and private interests. Topics have included respiratory protection, asbestos identification, evaluation, management, and control, advanced microscopy, polychlorinated biphenyls (PCBs), air pollution, industrial hygiene, and indoor air quality. He has directed over 50 courses and lectured in over 200 others throughout the continental United States, Alaska, Canada, and Europe.

Mr. Ewing participated in the site assessment of the aircraft carrier *USS Lexington* and development of its environmental management plan prior to its opening as a naval history museum. Much of this work involved PCBs, lead-based paint and asbestos identification and management. Mr. Ewing was responsible for preparing the Safety, Health and Emergency Response Plan (SHERP) and Contractor's Chemical Quality Control Program (CCQCP) for the fire site clean-up at Ft. Huachuca, Arizona. He has also conducted several studies related to flood or fire remediation in commercial and industrial facilities. Since 1988, he has participated in a series of studies designed to evaluate episodic exposures resulting from maintenance and custodial activities in buildings containing asbestos.

Certifications

American Board of Industrial Hygiene (ABIH) Certified Industrial Hygienist, Comprehensive Practice (Certificate No. 2627, Recertified 1990, 1995, 2002)	1983
Indoor Environmental Quality Sub-specialty Exam	1993
Inspector, pursuant to USEPA Asbestos Hazard Emergency Response Act (AHERA) regulations (40 CFR 763, Subpart E, Appendix C), Certificate No. 092, Georgia Institute of Technology; Current Certificate No. 3756-A, The Environmental Institute	1987-Present
Management Planner, pursuant to USEPA AHERA regulations, Certificate No. 083, Georgia Institute of Technology; Current Certificate No. 3756-A, The Environmental Institute	1987-Present
Project Designer, pursuant to USEPA AHERA regulations, Certificate No. 1438, The Environmental Institute; Current Certificate No. 1278-A, The Environmental Institute	1989-Present
Project Supervisor, pursuant to USEPA AHERA regulations, Certificate No. 3400, Georgia Institute of Technology; Current Certificate No. 3891-A, The Environmental Institute	1987-Present
State of Florida, Department of Professional Regulation, Licensed Industrial Hygienist/Asbestos Consultant (No. IA 0000003)	1989-Present

Awards and Honors

Georgia Tech Research Institute Award for Outstanding Performance in Program Development	1983
Commissioned Lieutenant Colonel, Aide de Camp, Governor's Staff by Governor Joe Frank Harris (State of Georgia)	1985
National Asbestos Council, President's Award Recipient	1987
National Asbestos Council, Outstanding Achievement Award	1988
Environmental Information Association, President's Award	1993
Elected Fellow Member Status, American Industrial Hygiene Association	1995

Memberships

American Industrial Hygiene Association (AIHA)	1978-Present
American Industrial Hygiene Association, Georgia Local Section	1979-Present
American Academy of Industrial Hygiene (AAIH)	1980-Present
American Conference of Governmental Industrial Hygienists(ACGIH)	1992-Present
American Society for Testing and Materials (ASTM)	1992-Present
Environmental Information Association (EIA)	1992-Present
International Society for Indoor Air Quality	1993-Present
National Asbestos Council (NAC)	1982-1992
National Institute for Building Sciences (NIBS)	1988-Present
New York Academy of Sciences (NYAS)	1987-Present

Offices Held

Environmental Information Association Georgia Chapter	
President	1997-1998
American Industrial Hygiene Association	1985-1986
Secretary, Georgia Local Section	
Environmental Information Association	1992-1993
Treasurer	
National Asbestos Council	
Board of Directors	1984-1986, 1988-1991
Secretary	1982-1983
Treasurer	1986-1987

Committees

American Industrial Hygiene Association	
Air Pollution Committee	1983-1984
Asbestos Task Force	1985
Indoor Environmental Quality Committee	1984-1986
Chair	1985-1986
Member/Corresponding member	1992-Present
Chair, Regulatory Affairs Committee	1995-1998
Policy, Standards & Guidelines Committee	1998-2002
Secretary	2002
International Council for Building Research Studies and Documentation	
Task Group for Dissemination of Indoor Air Sciences	1998-Present
National Asbestos Council	
Sampling and Analytical Committee	1984-1986
Professional Registration Committee	1988-1990
Publications Committee	1983-1990
Conference Committee, Chair of Professional Development Courses	1989-1990
San Antonio and Phoenix Conferences	
National Institute for Building Sciences	
Asbestos Task Force	1985-1988
Model Specifications Peer Review Committee (asbestos)	1988-1992, 1994-1996
Lead Based Paint Model O&M Manual Project Reviewer	1994

U.S. Environmental Protection Agency (USEPA)	
Asbestos NESHAP External Advisory Committee	1985-1986
Evaluation of Asbestos Control Technologies (Peer Review)	1985-1987
AHERA Regulatory Negotiation Committee, Invited Technical Advisor	1987
Policy Dialogue on Asbestos in Public and Commercial Buildings, Co-chair of Technical Working Group	1989-1990
Publication Peer Review (USEPA)	
"Measuring Airborne Asbestos Following An Abatement Action" Publication No. EPA 600/4-85-049 (November 1985)	1984-1985
"Guidelines for Conducting the AHERA Clearance Test to Determine Completion of an Asbestos Abatement Project" (1989)	1987-1988
"Guidance for Preventing Asbestos Disease Among Auto Mechanics," Publication No. EPA-560-OPTS-86-002 (June 1986)	1985-1986
"Interim Procedures and Practices for Asbestos Abatement Projects," Publication No. EPA 560/1-85-002 (June 1985)	1984-1985
National Institute for Occupational Safety and Health (NIOSH)	
Publication Peer Review	
"A Guide to Respiratory Protection for the Asbestos Abatement Industry," Publication No. NIOSH/EPA 560-OPTS-86-001 (September 1986)	1985-1986
"An Evaluation of Glove Bag Containment in Asbestos Removal," Publication No. DHHS(NIOSH) 90-119 (October 1990)	1987-1988
Department of the Navy, Naval Facilities Engineering Command	
Publication Peer Review	
"Removal and Disposal of Asbestos Materials," NAVFAC Guide Specification NFGS-02080 (May 1985)	1985
Asbestos Monitor	
Editorial Review Board	1988-1993
City of New York, Department of Environmental Protection (NYC/EPD) Expert Advisory Board	1987-1988
American Society for Testing and Materials (ASTM)	
D22 Committee on Sampling and Analysis of Atmospheres	1992-Present
D22.07 Asbestos	1992-Present
E-6 Performance of Buildings	
Subcommittee 23, Lead Hazard Abatement	1994-Present
Health Effects Institute (HEI) Research Advisory Committee	1988-1989
Environmental Information Association (EIA)	1992-Present
Editorial Review Board (Peer Reviewer)	1992-1998
Asbestos Committee (Co-Chair)	1998-2000
Building Owners and Managers Association Asbestos Committee	1987-1989

US Army Corps of Engineers, Facilities Engineering Support Agency 1984-1985
Publication Peer Review
"Asbestos Management and Control Handbook," TRADOC, Ft. Monroe, VA

Papers and Formal Presentations

"Formaldehyde Testing in New and Occupied Mobile Homes," paper presented at the University of Texas, Austin, TX, February 1982.

"Air Sampling at 52 Asbestos Abatement Projects," paper presented at the American Industrial Hygiene Conference, Philadelphia, PA, May 1983.

"Use of Chloride-Containing Aerosol for Source Recognition During an Indoor Air Quality Contamination," with W.H. Spain, A.A. Block, and W.A. Orenstein; paper presented at the American Industrial Hygiene Conference, Detroit, MI, May 1984.

"Health Issues and Legal Aspects of Asbestos Exposure in Buildings," Strategic Planning for Cogeneration and Energy Management: Proceedings of the 8th World Energy Engineering Congress, Atlanta, GA, with E. Clay and W.H. Spain, 1985.

"Determining Emissions from Negative Air Machines During Asbestos Abatement Projects," with E. Clay W.H. Spain and J. Hubbard, paper presented at the 1985 American Industrial Hygiene Conference, Las Vegas, NV, May 1985.

"Field Testing of High Efficiency Respirator Filters Against Airborne Asbestos Fibers," with E. Clay, W.H. Spain, and J. Hubbard, paper presented at the 1985 American Industrial Hygiene Conference, Las Vegas, NV, May 1985.

"Asbestos Abatement Disposal Techniques and Airborne Exposures for Contractor Personnel," with W.H. Spain and E. Clay, paper presented at the 1985 American Industrial Hygiene Conference, Las Vegas, NV, May 1985.

"Asbestos Policy During the Carter Administration," paper presented at the Jimmy Carter Presidential Library, Atlanta, GA, May 1987.

"Asbestos Exposure During and Following Cable Installation in the Vicinity of Fireproofing," with J. Chesson, T. Dawson, et al., paper presented at the 1991 American Industrial Hygiene Conference, Salt Lake City, UT, May 1991.

"An Investigation of Airborne Asbestos Concentrations During Custodial and Maintenance Activities in a Boiler Room," with E. Ewing, S. Hays, et al., paper presented at the 1992 American Industrial Hygiene Conference, Boston, MA, June 1992.

"An Equation to Express the Decay of Airborne Chrysotile Concentrations," with J. Millette and D. Keyes, poster paper presented at the Health Effects Institute - Asbestos Research Operations and Maintenance Workshop, Cambridge, MA, March 1993.

"Baseline Studies of Asbestos Exposure During O&M Activities," with D. Keyes, S. Hays, et al., paper presented at the Health Effects Institute - Asbestos Research Operations and Maintenance Workshop, Cambridge, MA, March 1993.

"Libby…A Historical Perspective," ASTM 2002 Johnson Conference, Johnson State College, Johnson, VT, July 21-25, 2002

"Asbestos in Settled Dust Concentrations Outdoors in New York City Before September 11, 2001," ASTM 2002 Johnson Conference, Johnson State College, Johnson, VT, July 21-25, 2002

Publications

Ewing, W.M., "Clearance Sampling and the Fiber Counting Method," *National Asbestos Council Newsletter*, Vol. 1, No. 2 (June 1983).

Ewing, W.M. and W.H. Spain, "Getting to the Very Fiber of Industrial Asbestos Removal," *Occupational Health and Safety*, Vol. 53, No. 6 (June 1984).

Spain, W.H., W.M.Ewing, and E.M. Clay, "Knowledge of Causes, Controls and Prevention of Heat Stress," *Occupational Health and Safety*, Vol. 54, No. 4 (April 1985).

Clay, E.M., W.H. Spain, and W.M. Ewing, "Health and Safety Needs Detailed in New Asbestos Abatement Survey," *Occupational Health and Safety*, Vol. 54, No. 8 (August 1985).

Block, A.B., W.A. Orenstein, W.M. Ewing, et al., "Measles Outbreak in a Pediatric Practice: Airborne Transmission in an Office Setting," *Pediatrics*, Vol. 75, No. 4 (April 1985).

Clay, E.M., M. Demyanek, W.M. Ewing, and W.H. Spain, "Protective Clothing: Its Necessity and Use," *National Asbestos Council Journal*, Vol. 2, No. 2 (1985).

Ewing, W.M., "History, Implementation and Evaluation of the Asbestos School Hazard Detection and Control Act of 1980," *National Asbestos Council Journal*, Vol. 4, No. 2 (1986).

Spain, W.H., E.M. Clay, W.M. Ewing, and M. Demyanek, "Protective Clothing, A Worthwhile Precaution for Asbestos Workers," *Occupational Health and Safety*, Vol. 55, No. 8 (August 1986).

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Spain, W.H., E.M. Clay, and W.M. Ewing, "Special Problems with Respirators for Asbestos Abatement," *ECON*, Vol. 3, No. 9 (September 1988).

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Spain, W.H., W.M. Ewing, and N.P. Wickware, "Asbestos Floor Tile Removal," *Asbestos Issues*, Vol. 2, No. 9 (September 1989).

Hutton, M.D., W.W. Stead, G.M. Cauthen, A.B. Block, and W.M. Ewing, "Nosocomial Transmission of Tuberculosis Associated With a Draining Abscess," *Journal of Infectious Disease*, Vol 161 (February 1990).

Millette, J.R., W.M. Ewing, and R. Brown, "Stepping on Asbestos Debris," *Microscope*, Vol. 38, pp. 321-326 (1990).

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Ewing, W.M., et al., *Georgia Building Authority Indoor Air Quality Manual*, Georgia Building Authority, Atlanta, GA (May 1997).

Ewing, W.M., "Further Observations of Settled Asbestos Dust in Buildings," in *Advances in Environmental Measurements for* Asbestos by M.E. Beard and H. L. Rook (Editors) ASTM Publication STP 1342, West Conshohocken, PA (1999), pp. 323-332.

Ewing, W.M., et al., *Lead Hazard Evaluation and Control in Buildings*, ISBN 0-8031-2086-9, ASTM Stock Number MNL38, ASTM, West Conshohocken, PA (2000)

Book Reviews

Thomas, J.D.R. (editor), Ion-Selective Reviews (Vol. 1, No. 1), *American Industrial Hygiene Association Journal*, Vol. 42, No.4 (April 1981).

National Council on Radiation Protection and Measurements, Quantitative Risk in Standard Setting, *American Industrial Hygiene Association Journal*, Vol. 43, No. 2 (February 1982).

State Planning Council (Washington, DC), The Interim Report of the State Planning Council on Radioactive Waste Management, *American Industrial Hygiene Association Journal*, Vol. 43, No. 1 (January 1982).

American Conference of Governmental Industrial Hygienists, Advances in Air Sampling, *American Industrial Hygiene Association Journal*, Vol. 50, No. 5 (May 1989).

DEPOSITION LIST FOR WILLIAM M. EWING, CIH 1998-2003

DATE	CASE NAME	JURISDICTION	CASE NUMBER
1998	Schwab v. AC&S, et al.	Illinois Circuit Court; Tazewall County, IL	96 L 105
1998	Salem Community Hospital v. W.R. Grace & Co., et al.	Cleveland, Ohio	Not known
1998	Norma I. Maysonet Robles, et al. V. United States Gysum Co.	Puerto Rico	97-1035(DRD)
1998	Chemical Bank v. Stanley Stahl	New York State Supreme Court	103367/04
1998	Leo Hart, et al. V. Abex Corp., et al.	Jackson County Circuit Court, Kansas City, MO	CV97-7137
1999	Deborah L. Balandron-Carnahan v. Copaken, White & Blitt, et al.	Jackson County Circuit Court; Kansas City, MO	98-CV-12771
1999	Charles & Shirlene Hicks v. Raybestos-Manhattan, Inc., et al.	Superior Court, County of San Francisco, CA	999242
1999	Kenneth & Edna Kugelman v. Asbestos Defendants (BHC)	San Francisco Superior Court	990559
1999	Ernest Valerio & Doris Valerio v. A&M Insulation Co., et al.	Circuit Court; Grundy County, IL	99 L 12
1999	John Smithgall, et al. v. Associated Environmental, Inc.	Fulton County State Court; Atlanta, GA	96VS-0116626
1999	Sheldon Solow, et al. v. W.R. Grace & Co., et al.	U.S. District Court, New York	Not known
1999	State of Hawaii v. W.R. Grace & Co., et al.	U.S. District Court, Honolulu, HI	93-4161-10
1999	Pennsylvania Dept. of General Services, et al. v. U.S. Mineral Products Co., et al.	Commonwealth Court of Pennsylvania Philadelphia, PA	284 MD 1990
2000	Sterets, et al. v. Raybestos-Manhattan, Inc. et al.	San Francisco Superior Court	Not known
2000	Port Authority of New York & New Jersey v. Affiliated FM Insurance	U.S. District Court for the Northern District of New Jersey	91-2907
2000	Lanora G. Satterfield, et al. v. AC&S, et al.	Circuit Court of Lawrence County, IL	99-L-11 99-L-6
2000	Mark Lewis & Shirley Hackett v. Raybestos-Manhattan, Inc., et al.	Superior Court, County of San Francisco, CA	320036
2000	Dorothy S. Jones v. AC & S, et al.	Circuit Court of Milwaukee County, WI	99-CV-3542
2001	Marilyn Thornberry, et al. v. AC&S, et al.	Circuit Court of Cook County, IL	99-L-6180
2001	Thomas L. Srenaski, Jr. v. Allied Signal, Inc., et al.	State of Wisconsin Circuit Court; Door County	99 CV 080
2001	James Castor v. Raybestos-Manhattan, Inc., et al.	Superior Court, County of San Francisco, CA	320036
2001	David Taylor & Susan Taylor v. Raybestos-Manhattan, Inc., et al.	Superior Court, County of San Francisco, CA	320278
2001	George Green, et al. v. Dayco, et al.	North Carolina Industrial Commission	047397
2001	Cigna v. Didimoi Property Holdings, N.V., et al.	Pennsylvania (Philadelphia)	00-186-JJF
2001	Polly Burns & Brad Burns v. Raybestos-Manhattan, Inc., et al.	Superior Court, County of San Francisco, CA	320774
2001	Donna Hansen v. Raybestos-Manhattan, Inc., et al.	Superior Court, County of San Francisco, CA	321639

2001	Don Lee Henderson and Marlene Henderson v. A C and S, et al.	Superior Court, County of Alameda, CA	843027-6
2001	Marvin Boede, et al. v. Wisconsin Electric Power Company, et al.	Milwaukee County Circuit Court, WI	98-CV-006561
2001	Lois A. Smerker, et al v. A & M Insulation Co., et al.	Circuit Court of Will County, IL	99 L 686
2002	In RE: Asbestos Personal Injury Litigation – West Virginia	Circuit Court of Kanawha County, WV	01-C-9002
2002	State of Illinois v. United States Gypsum, et al.	Circuit Court of Sangamon County, IL	98-L-0061
2002	Several personal injury (mesothelioma) cases	Superior Court, County of San Francisco, CA	Not known
2002	Armstrong Bankruptcy (Illinois, LAUSD)	Federal Bankruptcy Court, Delaware	Not known
2002	Lucy Choate v. ? (personal injury-mesothelioma)	New Orleans, LA	Not known

Updated March 18, 2003

TRIAL LIST FOR
WILLIAM M. EWING, CIH
1998-2003

DATE	CASE NAME	JURISDICTION	CASE NUMBER
1998	James C. Westberry & Connie R. Westberry v. Mataki Kemi, AB & Gislaved Gummi, AB	U.S. District Court, Anderson, SC	97-562-13
1998	Port Authority of New York & New Jersey v. Allied Corp., et al.	U.S. District Court for the Southern District of New York	91 CIV 0310
1999	Kenneth & Edna Kugelman v. Asbestos Defendants (BHC)	San Francisco Superior Court	990559
1999	Charles & Shirlene Hicks v. Raybestos-Manhattan, Inc., et al.	County of San Francisco Superior Court	999242
1999	Pennsylvania Dept. of General Services, et al. v. U.S. Mineral Products Co., et al.	Commonwealth Court of Pennsylvania; Philadelphia, PA	284 MD 1990
2000	Public Service Building v. Pacific Gas & Electric Co.	State of Oregon, Portland, OR	Not known
2000	Mark Lewis & Shirley Hackett v. Raybestos-Manhattan, Inc., et al.	County of San Francisco Superior Court	306774
2000	Sterets, et al. v.	County of San Francisco Superior Court	Not known
2001	Marvin Boede, et al. v. Wisconsin Electric Power Co., et al.	Circuit Court, County of Milwaukee, WI	98-CV-006561
2001	David Taylor and Susan Taylor v. Raybestos-Manhattan, et al.	County of San Francisco Superior Court	320278
2001	Don Lee Henderson and Marlene Henderson v. A C and S, et al.	Superior Court, County of Alameda, CA	843027-6
2002	Marvin Boede, et al. v. Wisconsin Electric Power Company, et al.	Milwaukee County Circuit Court, WI	98-CV-006561
2002	In RE: Asbestos Personal Injury Litigation – West Virginia	Circuit Court of Kanawha County, WV	01-C-9002

ATTACHMENT 2

ZONOLITE INSULATION EXPOSURE STUDIES

Study Participants:

William M. Ewing, CIH
Tod A. Dawson
Compass Environmental, Inc.

Richard Hatfield
William E. Longo, Ph.D.
Paul Liss
Materials Analytical Services, Inc.

Steve M. Hays, PE, CIH
Ron V. Gobbell, FAIA
Pete Cappell
Gobbell Hays Partners, Inc.

March 15, 2003

ZONOLITE INSULATION EXPOSURE STUDIES
March 15, 2003

EXECUTIVE SUMMARY

A series of studies were designed and conducted to evaluate amphibole asbestos exposures during specific activities in homes containing Zonolite vermiculite insulation. The activities selected for evaluation included the following.

- Cleaning of stored items in an attic with Zonolite at perimeter only
- Cutting a hole in a ceiling of a living space below Zonolite attic insulation (ZAI)
- Moving aside Zonolite attic insulation using the Grace method
- Moving aside Zonolite attic insulation using a homeowner method
- Removal of Zonolite insulation from top of wall cavities with a shop vacuum

The field work for these studies was conducted during the week of November 4, 2002 at two homes in the Spokane, Washington area. The cleaning activity and the removal of Zonolite insulation with a shop vacuum occurred in a home with Zonolite exposed at the top of perimeter wall cavities only. The other activities were performed in a home with ZAI throughout the attic space. A total of 162 personal and area air samples were collected and analyzed as part of the exposure study. Surface dust samples and bulk samples were also collected and analyzed. The results are briefly summarized below.

Activity	Worker Exposure			Area	
Evaluated	f/cc	s/cc	s/cc>5µm	s/cc	s/cc>5µm
Cleaning items in an attic	1.54	<0.42[1]	<0.42	0.08	0.07
Cutting a hole in a ceiling	5.8	2.48	1.32	0.62	0.52
Moving ZAI (Grace method)	12.5	6.29	4.85	2.30	1.85
Moving ZAI (homeowner method)	14.4	20.0	16.0	2.35	5.56
Shop vacuum removal	2.90	1.47	0.98	0.77	0.53
No activity	-	-	-	<0.003	<0.003

[1] Best estimate of worker exposure from area samples collected in the cleaning area is 0.12 s/cc and 0.11 s/cc, great than 5 µm.

ZONOLITE INSULATION EXPOSURE STUDIES
March 15, 2003

INTRODUCTION

A series of studies were designed and conducted to evaluate amphibole asbestos exposures during specific activities in homes containing Zonolite vermiculite insulation. The activities selected for evaluation included the following:

- Cleaning of stored items in an attic with Zonolite at the perimeter only
- Cutting a hole in the ceiling of a living space below Zonolite attic insulation
- Moving aside Zonolite attic insulation using the Grace method
- Moving aside Zonolite attic insulation using a homeowner method
- Removal of Zonolite insulation from the top of wall cavities with a shop vacuum

The field work for these studies was conducted during the week of November 4, 2002 at two homes in the Spokane, Washington area.

Acknowledgements

Funding for the studies was provided through the firm of Richardson, Patrick, Westbrook and Brickman of Charleston, SC from funds authorized by the bankruptcy court. The study participants are grateful for the financial support of this project. We also acknowledge Mr. Darrell W. Scott, Mr. Kelly Konkright, Ms. Kristy Bergland, and Ms. Samantha Batorson of Lukins and Annis for their assistance with the logistics necessary to conduct the work in the Spokane area.

The study design, methods used, field work, analytical work, and this report are the product of the study participants. The study participants included William M. Ewing, CIH and Tod A. Dawson of Compass Environmental, Inc.; Mr. Richard Hatfield, Dr. William Longo, and Mr. Paul Liss of Materials Analytical Services, Inc.; and Mr. Steve M. Hays, PE, CIH, Mr. Ron V. Gobbell, FAIA, and Mr. Pete Cappel of Gobbell Hays Partners, Inc.

We recognize the work by the staff of Fulcrum Environmental Consulting of Spokane for their assistance during the field work, and during the post-study remediation work that occurred. We appreciate the efforts of IRS Environmental of Spokane for their work in containment and decontamination facility construction during the field work, and remediation work at the conclusion of the project.

Lastly, we acknowledge the assistance and cooperation of the homeowners who permitted us access to their homes and agreed to temporarily relocate to allow the study to proceed. This work would not have been possible without their cooperation.

METHODS AND PROCEDURES

Selection of Homes

Mr. Richard Hatfield visited over a dozen homes, 10 of which were in the eastern Washington, northern Idaho area. The purpose of these visits included evaluating which homes might be available and suitable for testing. The primary criteria were the presence of Zonolite vermiculite used as insulation in the home. The homes needed to be available for sampling over approximately a 3-4 day period. The testing performed would not subject the occupants to any additional exposure to asbestos. The homes selected needed to have reasonable access to the areas (attics) where testing would be conducted. Homes having blown-in cellulose or mineral wool insulation, in conjunction with the Zonolite insulation were also not selected. The availability of electricity and water was also a criterion. Initially three homes met these criteria. One of these homes was later deemed not suitable since the family could only be relocated for 2-3 days.

View of Busch Home
1512 West 14th Avenue
Spokane, WA

View of Matthews Home
2207 South Adams Road
Spokane, WA

Selection of Activities

A series of teleconference meetings were held to plan the project and review the proposed study design. Possible activities to test were raised and discussed. The possibilities included cleaning activities, service work, maintenance work, remodeling work, renovation work, and demolition work. Home demolition was considered beyond the scope of this project, and a similar activity had already been studied by the Canadian government.[2] No activity was also considered, and selected, to provide a baseline for comparison with other activities to be tested. Long-term sampling in occupied homes was not considered feasible due to time and budgetary constraints. The criteria for the activities selected for testing were those activities that commonly occur in homes that might reasonably be expected to disturb in-place Zonolite insulation, or the dust/debris from that insulation. The activities selected were 1.) no activity, 2.) cleaning stored items

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[2] Pinchon Environmental, *Final Report, Site Assessment, Vermiculite Removal, Building E-12, C.F.B. Shilo, Shilo Manitoba*, Report prepared for Department of National Defense, Base Construction Engineering, Canadian Forces Base Shilo, Shilo, Manitoba R0K 2AG, April 3, 1997.

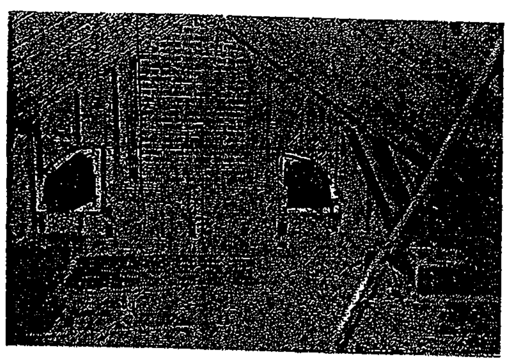
in an attic having Zonolite insulation at the perimeter only, 3.) cutting a hole in the ceiling of a living space with Zonolite attic insulation above, 4.) moving aside a known amount of Zonolite attic insulation using two different methods, and 5.) removing Zonolite insulation from the top of perimeter wall cavities with a shop vacuum.

Description of Activities Performed

Before conducting testing, the area where each activity would occur was separated from the rest of the house by erecting a two-stage decontamination station at the entrance to the attic or room. Each decontamination station consisted of two small rooms (approximately 4'x 4' separated by plastic flap doorways. The inlet for a high efficiency particulate air (HEPA) filtered vacuum was placed in the room closest to the work area. The decontamination station was designed to prevent activity-generated dust from migrating out of the attic or room. It also served as a location for persons to change out of personal protective equipment, wash, and clean equipment. As necessary, 4' suspended shop lights were installed to provide better lighting. Area sampling equipment, extension cords, tripods, and miscellaneous tools/supplies necessary to perform the tasks were brought into the area.

After the activity was performed, any items removed from the area were HEPA vacuumed and wet cleaned. Accessible Zonolite insulation in the attics of the two homes was removed by a state of Washington licensed asbestos abatement contractor (IRS Environmental, Inc., Spokane, WA). During and after the activities, area air sampling was conducted by a local consulting firm to determine if asbestos had migrated to occupied locations, or if the attics were clean after abatement (Fulcrum Environmental Consulting, Inc.).

Cleaning of Stored Items in an Attic with Zonolite at the top of Wall Cavities Only – This activity was perform in the attic of the Matthews home at 2207 South Adams Road in Spokane, WA. In this home the Zonolite insulation was limited only to the perimeter (primarily the east and west sides) of the attic space at the top of the wall cavities. The cleaning activity was performed by one individual with an assistant to help move trunks and boxes. The cleaning consisted of dusting the top surfaces of stored boxes (approximately 8), trunks (2), and fishing tackle with new cotton cloths and sweeping exposed wood floor areas with a corn broom.[3] Rugs on the attic floor were cleaned with a standard upright vacuum cleaner.[4] These procedures were performed in a manner described by the homeowner. The homeowner reported the attic had last been cleaned



View of Attic Area Cleaned

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[3] Harper brand, model No. 100, Harper Brush Works, Fairfield, IA 52556

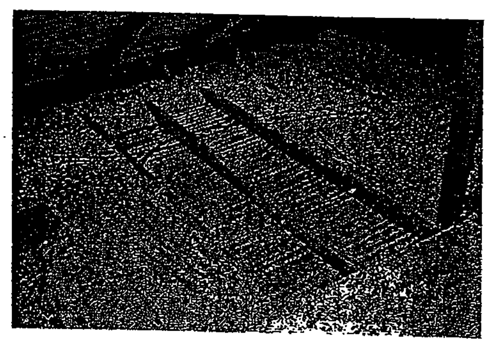
[4] Eureka brand Upright Vacuum Cleaner, Household Type, Model No. 7600, The Eureka Company, Bloomington, IL 61710

two years prior to this work. Approximately one half of the attic floor area was cleaned, or approximately 390 ft.^{2} The cleaning activity took 31 minutes to complete (in the order performed, sweeping-1 minute, dusting-13 minutes, vacuuming-17 minutes).

Cutting a Hole in the Ceiling of a Living Space Below Zonolite Attic Insulation – This activity was performed at the Busch home located at 1512 West 14th Avenue in Spokane, WA. The activity was performed by one person who cut an opening in the ceiling measuring 15"x 24" in a room measuring 11'2"x 13'4", with the assistance of a second person. The ceiling material itself consisted of a stipple finish on 1/4" wallboard, one layer of wallpaper, finish hard plaster, and a coating of gray hard plaster, on wood lathe. The area in the attic above the cutting location was inspected for electrical wiring as a safety precaution. The cutting was started by drilling a 2" diameter hole at one corner of the rectangle to be cut with a power drill equipped with a keyhole saw bit. The remainder of the cutting was performed with a Stanley brand 12" hand operated compass saw.[5] The entire cutting activity took 24 minutes to complete (in the order performed, drilling starting hole – <1 minute, remainder of time hand sawing with periodic short rest breaks). The average depth of Zonolite insulation above the cutout area was 4 inches.

View of Ceiling After Cutting

Moving Aside Zonolite Attic Insulation (Grace Method[6]) – This activity was performed in the attic of the Busch home located at 1512 West 14th Avenue in Spokane, WA. The floor square footage of the attic was 756 ft.^{2} (28'x 27'). This activity was performed by one person with the assistance of a second. The activity consisted of removing approximately 15 ft.^{2} (2'6"x 6') of Zonolite attic insulation having an average depth of 5" from between the floor joists. This material was misted with water using a hand held pump-up garden sprayer immediately before the work began. The Zonolite was scooped from between the floor joists and into plastic bags using a plastic dustpan. The remaining visible dust and debris was removed using a



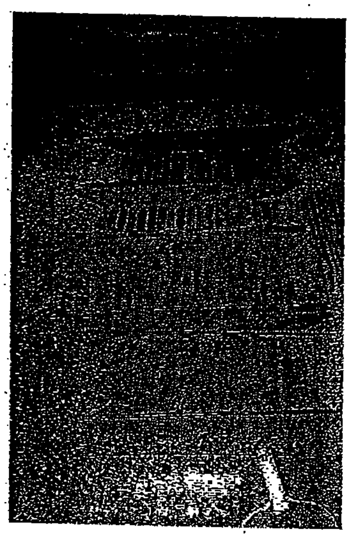
View of Zonolite in Attic after Moving by Grace Method

[5] Both the keyhole saw and the compass saw were 8 point saws, having 8 teeth to the inch.

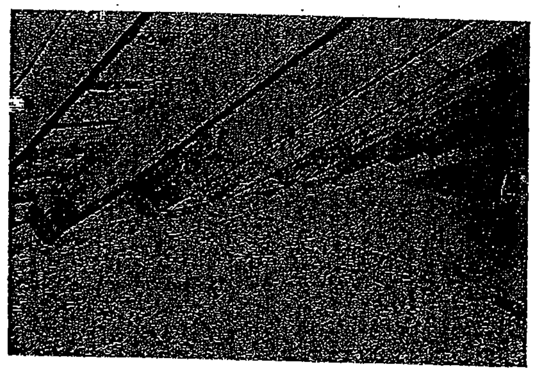
[6] In re: W.R. Grace & Co., et al., Debtors (Case No. 01-01139), U.S. District Bankruptcy Court for the District of Delaware; Debtors' Answers and Objections to ZAI Claimants' First Set of Interrogatories to Debtors, Answer to interrogatory no. 27, August 23, 2002.

new HEPA filtered vacuum cleaner.[7] The activity took 33 minutes to complete (in the order performed, 2 minutes – misting with water, 25 minutes – scooping Zonolite into plastic bags, 6 minutes – HEPA vacuuming).

Moving Aside Zonolite Attic Insulation (Homeowner Method) – This activity was performed in the same attic as the previous test.. The activity consisted of removing approximately 14.4 ft.^{2} (2'8"x 5'5") of Zonolite attic insulation having an average depth of 5" from between the floor joists. The work was performed using the same methods except the Zonolite was not misted with water at the start of the work and a whiskbroom and plastic dust pan was used to remove the visible dust and debris at the end of the work.[8] The work took 29 minutes to complete (in the order performed, scooping Zonolite into plastic bags – 15 minutes, whiskbroom to clean dust and debris – 14 minutes).



View of Zonolite in Attic after Moving by Homeowner Method



View of Zonolite at Top of Wall Cavity Before Shop Vacuum Removal

Removal of Zonolite Insulation From the Top of Wall Cavities with a Shop Vacuum - This activity was performed in the attic of the Matthews home at 2207 South Adams Road in Spokane, WA. The removal activity was performed by one individual with an assistant. The work consisted of removing approximately 60 linear feet of Zonolite insulation from a trough at the perimeter of the attic having an average width of 5.5" and depth of approximately 4". The equipment used to remove the Zonolite was a standard shop vacuum.[9] The work took 44 minutes to complete, and consisted of vacuuming up Zonolite until the shop vacuum was about half full (approximately 3 gallons) and

[7] Ridgid brand, model no. WD09350 (9 gallon) manufactured by Emerson Electric Co., with a Trapmax 3 model no. VF6000 HEPA filter rated at 99.97% efficient down to 0.3 microns installed.
[8] O Ceder brand corn whiskbroom, 10" long , bristle spread 8" by 1"
[9] Ridgid brand, model no. WD0620 (6 gallon) manufactured by Emerson Electric Co., with part no. VF4000 filter installed.

dumping the contents into a plastic trash bag. The shop vacuum was emptied 7 times during this work activity.

Personnel Protection – Prior to the start of any field work, and again at the work sites all personnel were briefed on the project and the known health and safety hazards likely to be encountered. During the testing, any persons entering the attics or other work areas were required to wear respiratory protection and two layers of full body protective clothing. Full-face powered-air purifying respirators equipped with P-100 filters approved by the National Institute for Occupational Health and Safety (NIOSH).for use against asbestos. Personnel decontamination was performed on site through the use of a HEPA filtered vacuum followed by wet washing. A first aid kit was available for use as needed. No accidents or injuries occurred during the project.

Sampling Methods

Air, dust and bulk samples were collected as part of this project. The methods used were all routinely employed by the study team. No special training or new sampling methods were necessary. For all samples, sample logs and chain-of-custody forms were completed. Air, dust and bulk samples were stored and transported separately to minimize the opportunity of cross-contamination between samples. The methods employed are described below.

Amphibole asbestos species identified by electron microscopy or polarized light microscopy in air, dust or bulk samples are reported herein as "Libby amphiboles." The Libby amphiboles consist of fibrous tremolite, richterite, winchite, and actinolite.[10,11]

Air Sampling and Analyses

Personal and area air sampling was conducted. Personal samples were collected in the breathing zone of the person, but outside the full-face respirator. The personal samples were secured to the full-face respirator at approximately eye level so the sample would not be located in the exhaust of the powered-air respirator. The filter cassettes were positioned at approximately a 45-degree angle pointed downward. Personal samples were collected using battery-operated air sampling pumps calibrated before and after each set of samples during an activity.[12] Area samples were collected using electric air sampling pumps.[13] All personal sampling pumps were calibrated on-site using a primary flow

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[10] For additional information on the nomenclature, see Wylie, Ann G. and J.R. Verkouteren, Amphibole Asbestos from Libby, Montana; Aspects of Nomenclature, American Mineralogist, Vol. 85, pp. 1540 – 1542 (2000).

[11] For additional information on the chemical and physical properties of Libby amphiboles see Meeker, G.P., et. al., The Chemical and Physical Properties of Amphibole from Libby, Montana: A Progress Report, U.S. Geological Survey, USEPA Health Effects of Asbestos Conference, Oakland, CA, May 24-25, 2001.

[12] Mine Safety Appliance (MSA) brand model ELF sampling pumps and one MSA brand model Flowlite pump.

[13] Dawson brand Gast electric pumps

meter.[14] Area sampling pumps were calibrated on-site using a precision rotometer. The rotometer was last calibrated on September 30, 2002 against a bubble meter.

Personal samples were collected in pairs. One sample was collected on a mixed cellulose ester (MCE) membrane filter (25 mm diameter) having a pore size of 0.8 micrometers (µm). The other sample in the pair was collected on the same type of filter with a pore size of 0.45 µm. Personal samples were typically collected at flowrates between 0.5 and 1.0 liters per minute (l/min.) due to the dusty environment anticipated. Area samples were typically collected at flowrates of 7 – 10 l/min. in non-dusty environments and 2-4 l/min. in dusty environments.

During the testing, the personal and area air sample filters were visually inspected at least every 5 minutes to estimate dust loading. The sampling filters were changed whenever there was a visible discoloration of the filter surface to reduce the chance of excessive dust loading on the filters. Blank samples were collected at a rate of 10 percent or two per sampling batch, whichever was greater.

All air samples were submitted to Materials Analytical Services, Inc. (MAS) in Suwanee, Georgia for analyses. MAS is accredited by the American Industrial Hygiene Association (AIHA) and the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the National Institute of Standards and Technology (NIST). Personal air samples collected on 0.8 µm pore size MCE filters were analyzed by phase contrast microscopy (PCM) as described in NIOSH method 7400.[15] Personal and area air samples collected on 0.45 µm MCE filters were analyzed by transmission electron microscopy (TEM) using the direct preparation techniques described at 40 CFR 763, Subpart E, Appendix A.[16] The results of the PCM samples are reported as fibers per cubic centimeter of air sampled (f/cc). The results of the TEM samples are reported as structures per cubic centimeter of air samples (s/cc).

Dust Sampling and Analyses

Surface dust samples were collected as part of this study. Most samples were collected using ASTM method D 5755, Standard Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Concentrations. This method uses a sampling pump calibrated at 2 l/min. to vacuum dust onto a 0.45 µm pore size MCE filter from a measured surface area of typically 100 square centimeters (cm^2). These samples were analyzed by TEM as described in ASTM D 5755 and results reported as asbestos structures per square centimeter of surface area sampled (s/cm^2). Three additional surface samples were collected from a surface using 3M brand post-it notes and archived for possible future analyses.

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[14] Bios International Corp., DryCal DC-Lite Primary Flow Meter (S/N 6615).
[15] Issue 2, August 15, 1994.
[16] This method is commonly referred to as the EPA AHERA method.

Bulk Sampling and Analyses

Bulk samples were collected and analyzed by polarized light microscopy (PLM) as described by the method EPA-600/MR-82-020: Interim Method for the Determination of Asbestos in Bulk Insulation Samples. Results are reported as percent asbestos by volume.

SUMMARY AND DISCUSSION OF RESULTS

The results are summarized and discussed for each activity performed in the following sections. The individual sample results and laboratory findings are compiled in appendices A (air samples), B (surface dust samples), and C (bulk samples).

Cleaning of Stored Items in an Attic with Zonolite at top of Perimeter Wall Cavities Only

Four area air samples were collected before the start of cleaning activities. No asbestos structures were detected in these samples. A concentration of less than 0.002 s/cc is reported. During the cleaning activity the personal exposure measurements for the worker measured by PCM were 0.82 – 2.53 f/cc, with a time-weighted average (TWA) during the 33-minute time period of 1.54 f/cc. During a 34-minute time period the personal exposure measurements for the assistant measured by PCM was <0.54 – 0.82 f/cc, with a TWA of 0.53 f/cc.[17] No asbestos structures were detected in 3 samples collected on the worker and 3 samples collected on the assistant during the cleaning activity. The TWA values were <0.42 s/cc for the worker and <0.33 s/cc for the assistant.

Four sets of 3 area air samples (12 total) were collected during the cleaning activity and analyzed by TEM. The TWA (31 minutes) for the 3 samples in the group closest to the cleaning activity was 0.12 s/cc for all structures greater than 0.5 µm, and 0.11 s/cc for structures greater than 5 µm. The TWA (32 minutes) for the next closest set of 3 area air samples was 0.07 s/cc, greater than 5 µm in length. The TWA (32 minutes) for the next closest set of 3 area air samples was 0.06 s/cc, greater than 5 µm in length. The TWA (31 minutes) for the set of 3 area air samples farthest from the cleaning activity was <0.05 s/cc. No asbestos structures were detected in these three samples. The results for the air samples collected for this cleaning activity are summarized in Table 1.

[17] Note: a value of one-half the reported less than value was used to calculate the TWA.

Table 1. Summary of Air Sampling Results for Cleaning of Stored Items with Zonolite at the top of Perimeter Wall Cavities Only

Sample Location	N	PCM	TEM	
		(f/cc)	(s/cc)	(s/cc > 5μm)
Worker, personal	3, 3	1.54	<0.42	<0.42
Assistant, personal	3,3	0.53	<0.33	<0.33
Area, in cleaning area	3	-	0.12	0.11
Area, adjacent cleaning area	3	-	0.07	0.07
Area, ~10 feet away	3	-	0.06	0.06
Area, ~20 feet away 3	3	-	<0.05	<0.05
Area, before cleaning	4	-	<0.002	<0.002

Before the cleaning activity began 4 dust samples were collected from 4 non-porous attic surfaces. The results ranged from not detected to 38,000 s/cm^2, with an average (logarithmic mean) of 9500 s/cm^2. Three bulk samples of Zonolite collected from the attic perimeter were analyzed by PLM and found to contain a "trace" of Libby amphiboles, by volume.[18]

Just prior to the cleaning activity 4 sheets of aluminum foil were placed on surfaces to collect dust settling during a 23 hour period. The locations ranged from about 10 – 20 feet away from the cleaning activity so they would not need to be disturbed during the activity. No asbestos structures were found in the 4 dust samples collected from the foil sheets. Values of less than 300 s/cm^2 are reported for each sample.

This cleaning study highlights a short-coming in two commonly used air sampling methods when employed to measure fibers or asbestos structures in a "dusty atmosphere." The direct preparation TEM method requires that small sample volumes be collected to prevent overloading of the filter surface. Where the dust collected is predominantly asbestos, this is not a problem. Where the dust collected is predominantly not asbestos, the non-asbestos dust obscures the asbestos structures. The result is a higher than desirable sensitivity. For the PCM samples, the non-asbestos fiber content of normal house dust (primarily cellulose fiber) provides for a high fiber count, when only a fraction of those fibers are asbestos.

For this study, the three area air samples collected in the cleaning area provide the best asbestos fiber exposure information for an individual cleaning stored items in an attic with Zonolite located in the perimeter wall cavities. These data indicate an average exposure of 0.12 s/cc during cleaning, a value 60 times higher than the background measurements collected in the same area before the cleaning activity.

[18] Note: a trace finding by PLM is an estimate of some value less than 0.1%.

Cutting a Hole in the Ceiling of a Living Space Below Zonolite Attic Insulation

Prior to cutting the hole in the ceiling a set of 3 area air samples were collected in the second floor bedroom. The TEM analysis found an average of 0.023 s/cc, and 0.017 s/cc (greater than 5 μm in length). During the cutting process the worker and the assistant each wore two air sampling pumps for samples to be analyzed by PCM and TEM. Due to the dusty nature of the work, 4 sequential samples were taken for each pump (16 total). Four sequential samples were also collected at each of 3 area air sampling locations. These area samples were all analyzed by TEM.

The 4 PCM samples collected on the worker ranged from 1.42 f/cc to 14 f/cc, with a TWA of 5.8 f/cc during the 26 minute period. The 4 PCM samples collected on the assistant ranged from 0.81 f/cc to 16 f/cc, with a TWA of 5.4 f/cc during the 28 minute period.

The 4 TEM samples collected on the worker ranged from not detected (< 0.43 s/cc) to 4.98 s/cc (2.85 s/cc, greater than 5 μm). The 26 minute TWA for the worker was 2.48 s/cc (1.32 s/cc greater than 5 μm). The 4 TEM samples collected on the assistant ranged from not detected to 1.83 s/cc (all structures were greater than 5 μm). The 28 minute TWA for the assistant was 0.80 s/cc (greater than 5 μm).

The 3 sets of 4 TEM area air samples collected in the same room had TWA values of 0.51 s/cc (set 1), 0.57 s/cc (set 2), and 0.77 s/cc (set 3). Considering only structures greater than 5 μm, the corresponding values are 0.41 s/cc (set 1), 0.54 s/cc (set 2), and 0.60 s/cc (set 3).

The data demonstrate the peak exposures occurred during the last 5 minutes of cutting the hole when approximately 0.8 ft^3 of Zonolite spilled from the ceiling to the floor, a distance of about 9 feet. The TEM personal samples found 4.98 s/cc (2.85 s/cc >5μm) for the worker and 1.83 s/cc (all greater than 5 μm) during this phase of the work. The area air samples were similarly elevated during this phase of the work. The air sampling data are summarized in Table 2.

Table 2. Summary of Air Sampling Results During Cutting Hole in Ceiling Below Attic with Zonolite Insulation

Sample Location	N	PCM	TEM	
		(f/cc)	(s/cc)	(s/cc > 5μm)
Worker, personal	4,4	5.8	2.48	1.32
Assistant, personal	4,4	5.4	0.80	0.80
Area, sample set 1	4	-	0.51	0.41
Area, sample set 2	4	-	0.57	0.54
Area, sample set 3	4	-	0.77	0.60
Area, before activity	3	-	0.023	0.017

Three bulk samples of Zonolite attic insulation were collected and each found to contain less than 1% amphibole asbestos by PLM. A bulk sample of the ceiling that was cut was also analyzed by PLM for asbestos. The ceiling consisted of wood lathe, hard plaster, finish plaster, 1/4 inch gypsum wallboard with wallpaper, and a stippled finish coat. Approximately 7% chrysotile asbestos was found in the stippled finish coat. No asbestos was found in the other materials. Accordingly, the ceiling system material cut was less than 1% chrysotile.

Cutting a plaster/wallboard/wood ceiling is a dusty operation. The PCM method of measuring fiber concentrations in such an atmosphere is not a good predictor of asbestos exposure, The TEM data provides the best exposure information in this instance since the method can distinguish between asbestos and non-asbestos structures. The use of the direct TEM method to measure asbestos in an atmosphere with considerable non-asbestos dust remains a concern.

From these data it may be concluded that persons cutting a hole into a ceiling below Zonolite insulation will be exposed to significant concentrations of amphibole asbestos. The worker exposure was measured at over 100 times the background samples collected before the activity.

Moving Aside Zonolite Attic Insulation Using the Grace Method

Before moving any Zonolite attic insulation 3 area air samples were collected for TEM analyses. No asbestos structures were detected in these samples. A value of less than 0.002 s/cc is reported.

Personal samples were collected on the worker and the assistant during the activity. Four sequential samples were collected to prevent overloading of the filters for each sample set. Three sets of 4 area samples (12 total) were collected during this activity. The worker exposure was measured by 4 PCM samples and 4 TEM samples. For the assistant, the PCM and TEM analyses were performed on the same filters since the TEM filters were voided due to a pump malfunction (crimped sampling tube).

The PCM results for the worker ranged from 4.61 f/cc to 16.24 f/cc, with a 34 minute TWA of 12.5 f/cc. The PCM results for the assistant ranged from 2.29 f/cc to 4.25 f/cc, with a 34 minute TWA of 3.12 f/cc. The TEM results for the worker ranged from 1.01 s/cc to 10.6 s/cc (1.01 s/cc – 8.58 s/cc, greater than 5 μm), with a 34 minute TWA of 6.29 s/cc (4.85 s/cc, greater than 5 μm). The TEM results for the assistant ranged from 4.35 s/cc to 6.42 s/cc (1.16 s/cc to 4.67 s/cc, greater than 5 μm), with a 34 minute TWA of 5.50 s/cc (2.74 s/cc, greater than 5 μm).

The TEM results for the 3 sets of area air samples as 34 minute TWAs were 3.78 s/cc (set 1), 1.86 s/cc (set 2), and 1.25 s/cc (set 3). Considering only structures greater than 5 μm, the 34 minute TWAs were 3.17 s/cc (set 1), 1.48 s/cc (set 2), and 0.90 s/cc (set 3). The results for all the area and personal samples are summarized in Table 3.

Table 3. Summary of Air Sampling Results During Moving Zonolite Attic Insulation Using the Grace Method

Sample Location	N	PCM	TEM	
		(f/cc)	(s/cc)	(s/cc > 5μm)
Worker, personal	4,4	12.5	6.29	4.85
Assistant, personal	4	3.12	5.5	2.74
Area, sample set 1	4	-	3.78	3.17
Area, sample set 2	4	-	1.86	1.48
Area, sample set 3	4	-	1.25	0.90
Area, before activity	3	-	<0.002	<0.002

Moving Aside Zonolite Attic Insulation Using the Homeowner Method

A set of 3 background samples were collected from the attic before starting the activity. No asbestos structures were detected on these samples, and an average of <0.003 s/cc reported. The same sampling protocol was followed as was performed when moving the Zonolite using the Grace method.

The PCM results for the worker ranged from 9.48 f/cc to 18.81 f/cc, with a 31 minute TWA of 14.4 f/cc. The PCM results for the assistant ranged from 0.64 f/cc to 10.4 f/cc, with a 32 minute TWA of 4.98 f/cc. The TEM results for the worker ranged from 11.8 s/cc to 29.1 s/cc (10.5 s/cc to 22.0 s/cc, greater than 5 μm), with a 31 minute TWA of 20.0 s/cc (16.0 s/cc, greater than 5 μm). The TEM results for the assistant ranged from < 0.53 s/cc to 5.92 s/cc (<0.53 to 5.92 s/cc, greater than 5 μm), with a 32 minute TWA of 2.99 s/cc (2.51 s/cc, greater than 5 μm).

The TEM results for the 3 sets of area air samples as TWAs were 1.20 s/cc (set 1 – 28 minutes), 2.00 s/cc (set 2 – 39 minutes), and 3.85 (set 3 – 39 minutes). Considering only structures greater than 5 μm, the TWAs were 1.06 s/cc (set 1), 1.57 s/cc (set 2), and 2.93 s/cc (set 3). The results for the air samples are summarized in Table 4.

Table 4. Summary of Air Sampling Results During Moving Zonolite Attic Insulation Using the Homeowner Method

Sample Location	N	PCM	TEM	
		(f/cc)	(s/cc)	(s/cc > 5μm)
Worker, personal	4,4	14.4	20.0	16.0
Assistant, personal	4	4.98	2.99	2.51
Area, sample set 1	4	-	1.20	1.06
Area, sample set 2	4	-	2.00	1.57
Area, sample set 3	4	-	3.85	2.93
Area, before activity	3	-	<0.003	<0.003

The results of sampling during the two methods of moving aside Zonolite attic insulation demonstrate that neither method effectively controls the generation of amphibole asbestos dust. The Grace method found the worker exposure to be 3100 times background, and the homeowner method found the worker exposure to be 6700 times background. A review of the workers' individual sample results showed a significant exposure reduction during the last 9 minutes of the task using the Grace Method (see sample numbers B8G – 104 and B45G – 104). This was likely due to the use of the HEPA filtered vacuum to remove dust from between the attic floor joists during this time frame. Visually the air in the vicinity of the HEPA vacuum (and the worker) became clearer. It appears the HEPA vacuum was functioning to scrub dust particles from the air as well as capture dust at the surface. This observation is also supported by the exposure measurements taken on the worker during the homeowner method that did was not lower in the last set of personal samples.

Either method of moving Zonolite attic insulation is a dusty procedure. However, since much of the airborne fibrous dust is amphibole asbestos, the limitations of using PCM and direct TEM are not as pronounced. In a different attic that might contain Zonolite and another product, such as treated cellulose or mineral wool, interference from non-asbestos fibers would likely make sampling and analysis more challenging.

The use of water to mist the Zonolite attic insulation was not very effective as a dust suppressant. This may be due to the thickness of the attic insulation and the micaceous product itself. Caution should be used when using water on Zonolite attic insulation. Old, and poorly insulated electric wiring is often found in the loose attic fill material. This poses an electric shock hazard.

Removal of Zonolite Attic Insulation with a Shop Vacuum from the Top of Perimeter Wall Cavities

Before beginning the removal of Zonolite attic insulation from the top of perimeter wall cavities, a set of 4 area air samples were collected to establish the background

concentration of asbestos. No asbestos was detected in these samples and values of less than 0.0016 s/cc are reported.
Personal samples were collected on the worker and the assistant during the activity. Four sequential samples were collected to prevent overloading of the filters for each sample set. Four sets of 4 area samples (16 total) were collected during this activity. The worker exposure was measured by 4 PCM samples and 4 TEM samples. For the assistant, the PCM and TEM analyses were performed on the same filters since the TEM samples were voided due to a pump malfunction (crimped sampling tube).

The PCM results for the worker ranged from 1.19 f/cc to 5.28 f/cc, with a 46 minute TWA of 2.90 f/cc. The PCM results for the assistant ranged from 1.47 f/cc to 4.81 f/cc, with a 46 minute TWA of 2.90 f/cc. The TEM results for the worker ranged from 1.05 s/cc to 2.16 s/cc (0.58 s/cc to 1.32 s/cc, greater than 5 μm), with a 46 minute TWA of 1.47 s/cc (0.98 s/cc, greater than 5 μm). The TEM results for the assistant ranged from 0.67 s/cc to 2.15 s/cc (<0.67 s/cc to 1.79 s/cc, greater than 5 μm), with a 46 minute TWA of 1.69 s/cc (1.10 s/cc, greater than 5 μm).

The TEM results for the 4 sets of area air samples as TWAs were 0.52 s/cc (set 1 – 43 minutes), 0.67 s/cc (set 2 – 42 minutes), 0.89 s/cc (set 3 – 42 minutes), and 1.00 s/cc (set 4 – 45 minutes). Considering only structures greater than 5 μm, the TWAs were 0.37 s/cc (set 1), 0.45 s/cc (set 2), 0.57 s/cc (set 3), and 0.73 s/cc (set 4). The results for the air samples are summarized in Table 5.

Table 5. Summary of Air Sampling Results During Removal of Zonolite Insulation with a Shop Vacuum from the Top of Wall Cavities

Sample Location	N	PCM	TEM	
		(f/cc)	(s/cc)	(s/cc > 5μm)
Worker, personal	4,4	2.90	1.47	0.98
Assistant, personal	4	2.90	1.69	1.10
Area, sample set 1	4	-	0.52	0.37
Area, sample set 2	4	-	0.67	0.45
Area, sample set 3	4	-	0.89	0.57
Area, sample set 4	4		1.00	0.73
Area, before activity	4	-	<0.002	<0.002

Just prior to the removal activity, 4 sheets of aluminum foil were placed on surfaces to collect dust which might settle during the activity and for a period of 20 – 33 minutes following completion of the activity. The total collection time was 65 - 78 minutes. The individual results are found in Appendix B (samples MD – 10 through MD – 13). No structures were found in two of the samples (<300 s/cc reported). The other two samples found 300 s/cm^2 and 700 s/cm^2 of amphibole asbestos.[19] The data, when viewed together

[19] Note: a longer settlement time was not possible as the remediation contractor needed access to begin their work

with the area air sampling, indicate an hour would not be a sufficient settling time before starting a clean-up.

The worker and the assistant exposure data were very similar for this study. The likely cause is the worker and assistant worked together to dump the Zonolite from the vacuum into plastic bags. This was visually a dusty operation. The vacuum was equipped with a standard pleated filter which, while not HEPA rated, likely captured much of the dust generated.

The data from the use of a standard shop vacuum to remove Zonolite insulation demonstrates this activity results in significant exposure to amphibole asbestos. The worker exposure for this study was found to be 735 times the background samples collected before the activity began.

Miscellaneous Observations

The background samples collected in the attics of the two houses indicated that absent any disturbance, there was not an elevated concentration of asbestos in the air. Similar sampling should be conducted in homes during high wind storms. Anecdotal information from at least one homeowner indicates that some Zonolite insulation is blown out from wall cavities under certain circumstances.

During the cleaning, and removal with shop vacuum studies, area air sampling was also conducted in the living space of the home. The purpose of the sampling was to verify the effectiveness of the containment. However, it also served to measure pre-existing airborne asbestos concentrations. The results indicated the pre-existing airborne concentration was not elevated.

Two area air samples were also collected outdoors of the two homes. The analyses, found in Appendix A, did not detect any asbestos.

A total of 17 blank samples were collected and analyzed as part of the study. These blank samples were handled and analyzed in the same manner as the field samples. The results of these samples, included in Appendix A, demonstrate there was no systematic contamination of the field samples.